

WHAT IS CLAIMED IS:

1. An image processing system comprising a first image processing apparatus which records, on a recording medium, composite image information created by embedding invisible sub-information in visible main image information, and a second image processing apparatus which restores the sub-information from the composite image information recorded on the recording medium by the first image processing apparatus,
 - the first image processing apparatus including a pre-processing unit which performs, for main image information, pre-processing corresponding to pixel formation processing for image recording in the first image processing apparatus,
 - an embedding processing unit which creates composite image information by embedding sub-information in main image information in an invisible state using the main image information, the sub-information, and key information used to restore the sub-information, and
 - a recording unit which records the composite image information created by the embedding processing unit on a recording medium, and
 - the second image processing apparatus including an image input unit which inputs the composite image information from the recording medium on which the composite image information is recorded by the

recording unit of the first image processing apparatus,

a frequency component extracting unit which
extracts a spatial frequency component unique to the
key information from the composite image information
input by the image input unit, and

a reconstructing unit which reconstructs the
sub-information from the spatial frequency component
extracted by the frequency component extracting unit.

2. An image processing system comprising a first
image processing apparatus which records, on a
recording medium, composite image information created
by embedding invisible sub-information in visible main
image information, and a second image processing
apparatus which restores the sub-information from the
composite image information recorded on the recording
medium by the first image processing apparatus,

the first image processing apparatus including

a first pre-processing unit which performs,
for main image information, first pre-processing
corresponding to pixel formation processing for image
recording in the first image processing apparatus,

a second pre-processing unit which performs
geometric transformation with respect to the main image
information having undergone the first pre-processing
by the first pre-processing unit,

an embedding processing unit which creates
composite image information by embedding

sub-information in main image information in
an invisible state using the main image information,
the sub-information, and key information used to
restore the sub-information,

5 an inverse transformation unit which performs
transformation processing inverse to the transformation
processing by the second pre-processing unit with
respect to the composite image information created by
the embedding processing unit, and

10 a recording unit which records the composite image
information having undergone the inverse transformation
processing by the inverse transformation unit by
an alternate driving/recording scheme of alternately
forming even-numbered and odd-numbered pixels in a main
15 scanning direction of a recording device on a recording
line basis, and

 the second image processing apparatus including
 an image input unit which inputs the composite
image information from the recording medium on which
20 the composite image information is recorded by the
recording unit of the first image processing apparatus,

 a frequency component extracting unit which
extracts a spatial frequency component unique to the
key information from the composite image information
25 input by the image input unit, and

 a reconstructing unit which reconstructs the
sub-information from the spatial frequency component

extracted by the frequency component extracting unit.

3. A system according to claim 2, wherein
the first pre-processing unit thins out main image
information in accordance with pixel formation
5 processing for image recording in the first image
processing apparatus.

4. A system according to claim 3, wherein the
second pre-processing unit rotates the main image
information, which is thinned out by the first pre-
10 processing unit in advance, through a predetermined
angle, and then performs geometric transformation
to remove thinned-out portions from the main image
information, compresses effective portions of the
main image information, and performs reconstruction.

15 5. A system according to claim 2, wherein the
frequency component extracting unit extracts a spatial
frequency component of the key information from the
composite image information input by the image input
unit by using a frequency filter coefficient.

20 6. A system according to claim 2, wherein the
reconstructing unit extracts a change point at which
a sign changes from the spatial frequency component
extracted by the frequency component extracting unit,
obtains a reference phase of the spatial frequency
25 component by projecting the extracted change point,
calculates a deviation of each coordinates of the
spatial frequency component extracted by the frequency

component extracting unit from the obtained reference phase, and replaces a pixel value of a coordinate which deviates by not less than a predetermined threshold with a first value, and each of other pixel values with a second value, thereby reconstructing sub-information.

5 7. A system according to claim 2, further comprising a determining unit which determines authenticity of the recording medium on the basis of the sub-information reconstructed by the reconstructing unit.

 8. An image processing apparatus comprising:
 an image input unit which inputs composite image information from a recording medium on which the composite image information is recorded, which is
15 created by color difference modulation processing using visible main image information, sub-information embedded in the main image information in an invisible state, and key information used to restore the sub-information;

20 a frequency component extracting unit which extracts a spatial frequency component unique to the key information from the composite image information input by the image input unit; and

 a reconstructing unit which reconstructs the
25 sub-information from the spatial frequency component extracted by the frequency component extracting unit.

 9. An apparatus according to claim 8, wherein the

frequency component extracting unit extracts a spatial frequency component of the key information from the composite image information input by the image input unit by using a frequency filter coefficient.

5 10. An apparatus according to claim 8, wherein the reconstructing unit extracts a change point at which a sign changes from the spatial frequency component extracted by the frequency component extracting unit, obtains a reference phase of the spatial frequency
10 component by projecting the extracted change point, calculates a deviation of each coordinates of the spatial frequency component extracted by the frequency component extracting unit from the obtained reference phase, and replaces a pixel value of a coordinate which
15 deviates by not less than a predetermined threshold with a first value, and each of other pixel values with a second value, thereby reconstructing sub-information.

 11. An apparatus according to claim 8, further comprising a determining unit which determines
20 authenticity of the recording medium on the basis of the sub-information reconstructed by the reconstructing unit.

 12. An image processing apparatus comprising:
 an image input unit which inputs composite image
25 information from a recording medium on which the composite image information is recorded, which is created by color difference modulation processing using

visible main image information, sub-information embedded in the main image information in an invisible state, and key information used to restore the sub-information;

5 a color component information storage unit which stores color component information;

 a color component extracting unit which extracts a color component from the composite image information input by the image input unit on the basis of the color
10 component information stored in the color component information storage unit;

 a frequency component extracting unit which extracts a spatial frequency component unique to the key information from the color component extracted by
15 the color component extracting unit; and

 a reconstructing unit which reconstructs the sub-information from the spatial frequency component extracted by the frequency component extracting unit.

13. An apparatus according to claim 12, wherein
20 the color component extracted from the composite image information is a color component corresponding to a color of ink exhibiting a highest gradation characteristic when the composite image information is recorded, and information of the color component is
25 stored in the color component information storage unit.

14. An apparatus according to claim 12, wherein the color component extracted from the composite image

information is a color component corresponding to a color of ink exhibiting a highest gradation characteristic when the composite image information is input, and information of the color component is stored
5 in the color component information storage unit.

15. An image processing apparatus comprising:

an image input unit which inputs composite image information from a recording medium on which the composite image information is recorded, which is
10 created by color difference modulation processing using visible main image information, sub-information embedded in the main image information in an invisible state, and key information used to restore the sub-information;

15 an area extracting unit which extracts a local area from the composite image information input by the image input unit;

a color feature extracting unit which extracts a color feature in the local area extracted by the area
20 extracting unit from the local area;

a color combining unit which creates color component composite image information by combining color components on the basis of the color feature extracted by the color feature extracting unit;

25 a frequency component extracting unit which extracts a spatial frequency component unique to the key information from the color component composite

image information created by the color combining unit;
and

5 a reconstructing unit which reconstructs the
sub-information from the spatial frequency component
extracted by the frequency component extracting unit.

16. An image processing apparatus comprising:

10 an image input unit which inputs composite image
information from a recording medium on which the
composite image information is recorded, which is
created by color difference modulation processing
using visible main image information, sub-information
embedded in the main image information in an invisible
state, and key information used to restore the
sub-information;

15 an area extracting unit which extracts a local
area from the composite image information input by
the image input unit;

20 a color feature extracting unit which extracts a
color feature in the local area extracted by the area
extracting unit from the local area;

 a reconstruction parameter determining unit which
determines a reconstruction parameter on the basis of
the color feature extracted by the color feature
extracting unit;

25 a frequency component extracting unit which
extracts a spatial frequency component unique to the
key information from the composite image information

input by the image input unit; and

a reconstructing unit which reconstructs the sub-information from the spatial frequency component extracted by the frequency component extracting unit by using the reconstruction parameter determined by the reconstruction parameter determining unit.

17. An apparatus according to claim 16, wherein the reconstruction parameter comprises an amplification coefficient for amplifying the spatial frequency component, and the reconstructing unit includes an amplifying unit which amplifies the spatial frequency component by using the amplification coefficient.

18. An apparatus according to claim 16, wherein the reconstruction parameter comprises a threshold for binarizing the spatial frequency component, and the reconstructing unit includes a binarizing unit which binarizes the spatial frequency component by using the threshold.

19. An image processing method comprising:
inputting composite image information from a recording medium on which the composite image information is recorded, which is created by color difference modulation processing using visible main image information, sub-information embedded in the main image information in an invisible state, and key information used to restore the sub-information;

extracting a spatial frequency component unique

to the key information from the composite image
information input from the recording medium; and
reconstructing the sub-information from the
spatial frequency component extracted by extracting
5 the frequency component.

20. A method according to claim 19, wherein
extracting the frequency component includes extracting
a spatial frequency component of the key information
from the composite image information input from the
10 recording medium by using a frequency filter
coefficient.

21. A method according to claim 19, wherein
reconstructing includes extracting a change point
at which a sign changes from the spatial frequency
15 component, obtaining a reference phase of the spatial
frequency component by projecting the extracted change
point, calculating a deviation of each coordinate of
the spatial frequency component from the reference
phase, and replacing a pixel value of a coordinate
20 which deviates by not less than a predetermined
threshold with a first value, and each of other pixel
values with a second value, thereby reconstructing
sub-information.

22. A method according to claim 19, further
25 comprising determining authenticity of the recording
medium on the basis of the reconstructed sub-
information.

23. An image processing method comprising:

inputting composite image information from
a recording medium on which the composite image
information is recorded, which is created by color
5 difference modulation processing using visible main
image information, sub-information embedded in the
main image information in an invisible state, and key
information used to restore the sub-information;

10 extracting a color component from the composite
image information input from the recording medium on
the basis of the color component information stored in
a color component information storage unit;

extracting a spatial frequency component unique to
the key information from the extracted color component;
15 and

reconstructing the sub-information from the
extracted spatial frequency component.

24. An image processing method comprising:

inputting composite image information from
20 a recording medium on which the composite image
information is recorded, which is created by color
difference modulation processing using visible main
image information, sub-information embedded in the
main image information in an invisible state, and key
25 information used to restore the sub-information;

extracting a local area from the composite image
information input from the recording medium;

extracting a color feature in a local area
extracted the composite image information from the
local area;

5 creating color component composite image informa-
tion by combining color components on the basis of the
color feature extracted from the local area;

extracting a spatial frequency component unique to
the key information from the created color component
composite image information; and

10 reconstructing the sub-information from the
extracted spatial frequency component.

25. An image processing method comprising:

inputting composite image information from
a recording medium on which the composite image
15 information is recorded, which is created by color
difference modulation processing using visible main
image information, sub-information embedded in the main
image information in an invisible state, and key
information used to restore the sub-information;

20 extracting a local area from the composite image
information input from the recording medium;

extracting a color feature in the extracted local
area from the local area;

25 determining a reconstruction parameter on the
basis of the color feature extracted from the local
area;

extracting a spatial frequency component unique

to the key information from the composite image
information input from the recording medium; and

reconstructing the sub-information from the
spatial frequency component extracted by extracting
5 the frequency component by using the reconstruction
parameter determined on the basis of the color feature.